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Nest characteristics and breeding success of Sarus Crane, *Antigone antigone* (Linnaeus, 1758) (Aves: Gruidae) in different habitats at Dhanauri Wetland, Uttar Pradesh, India

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Abstract

In this study, we investigated various nest characteristics and breeding success of Indian Sarus Crane *Antigone antigone* (Linnaeus) in three different habitats at Dhanauri wetland, Uttar Pradesh, from June 2018 to October 2019. Fourteen nests were studied from nest building to hatching during the study period. The average nest height was 144.99±4.40 cm (mean ± standard error), 104.38±2.86 cm, and 112.93±2.44 cm in the perennial wetland (n=7), agricultural marshland (n=4), and village pond (n=3). Nests height from the ground level was positively correlated (R^2=0.81) to water depth. The breeding success was maximum in the nests of village pond (50.0%), followed by agricultural marshland (25.0%) and perennial wetland (15.3%). However, the level of disturbance was also more in the village pond compared to the agricultural marshland and perennial wetland. Our study suggested that Sarus Crane is able to tolerate human disturbance and breed successfully in such habitats.

Keywords: Breeding Success, Dhanauri Wetland, Nest Characteristics, Sarus Crane

Introduction

Sarus Crane, a vulnerable species (IUCN, 2007; BirdLife International, 2016), is the tallest flying bird in the world, and its vulnerability is primarily associated with wetland destruction (Sundar & Choudhary, 2003). To protect and conserve a vulnerable species, breeding success or nest survival is crucial, along with habitat selection, an important requirement for nest building (Zhu *et al.*, 2012). Western Uttar Pradesh comprises a variety of cultivated fields, mostly paddy and wheat, with the land flooded as perennial wetlands as a result of seasonal rainfall (Sundar, 2009). Sarus Crane has been observed to settle their nest in overwhelmed rice paddies, a harvested field that closely looks like a wetland (Sundar, 2009). Studies have shown that Sarus Cranes normally have two-three eggs in one clutch (Kathju, 2006), although there may be four eggs in a clutch in some cases (Sundar & Choudhary, 2005). A breeding pair has been shown to rear only one or two eggs per year (Sundar & Choudhary, 2003). The number of nests in different habitats with clutch size was also noted during the field visit. The number of successfully hatched divided by total eggs laid were considered as a hatching success (expressed in percentage). Young birds that are large enough to fly were considered as fledged. The number of fledged divided by total eggs laid were considered as overall breeding success (in percentage) (Borad *et al.*, 2002). However, the breeding success is directly related to the nest made by the Sarus Crane during their breeding season. Therefore, in the current study, we assessed the different characteristics of nests and their breeding success in three different habitats of Dhanauri wetland, Uttar Pradesh, India.

Material and Methods

Study area

Our study was conducted from June 2018 to Oct 2019 in Dhanauri Wetland (28° 20′ N and 77° 37′ E), covering an area of 40 hectares, and located in village Thasrana of

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Gautum Budh Nagar district in Uttar Pradesh (Figure 2). Dhanauri wetland is now considered as a major wetland to protect Sarus Crane. This wetland is primarily surrounded by agricultural land and also supports a diversity of other avian fauna.

Field observations

During our study, we followed a fixed route, which was visited twice a week to cover the maximum area near the wetland to record nests parameters. Nests were searched from the village roads (Figure 2), and most of them were approached immediately after the laying of the first egg. We recorded the location of each nest using Garmin e-Trex GPS. Nikon Binoculars were used for scanning the birds and their nests in the agricultural landscape on both sides of the road. Consequently, an area of 43 hectares of wetland and 10 village ponds associated with Dhanauri wetland was covered during the study (Figure 2). To avoid disturbance due to repeated visits, we installed camera traps to monitor nests (Figure 1). We recorded nest height and length (cm), depth of water (cm), the distance of nest from the mainland (m), clutch size, and area of water body per m^2. We interviewed local villagers for information on the nests, eggs, and breeding pairs.

Statistical Analysis

The data were presented as mean ± standard error (S.E.). One-way Analysis of Variance (ANOVA) was used to compare various nest parameters, i.e., Nest Height (NH), Nest Width (NW), Water Depth (WD) between different habitats. The level of significance was considered at $p<0.05$. Pearson correlation was also used to assess the relationship between nest height and water depth.

Figure 1. Camera trap (in red circle) used during the study.

Results

Submerged grass (*Cyperus*), cattail (*Typha*), and marsh wort (*Nymphoides indica*) were the main vegetation component of nests. However, the parents used paddy, *Oryza sativa* plants for building nests in agricultural areas. The breeding pair of Sarus Cranes began nest building in the month of July. Females performed most of the nest maintenance whenever the water level increased during the rainy season. Generally, nest building started 3-4 days before egg-laying. The Sarus Cranes laid their 2nd egg after 2-3 days of laying the 1st egg (Figure 3). Nest maintenance continued, and more aquatic vegetation was added throughout the incubation period (Figure 4) and till the hatching of the last egg. Female cleaned its nest regularly and kept rotating eggs with their beaks, as shown in Figure 5.

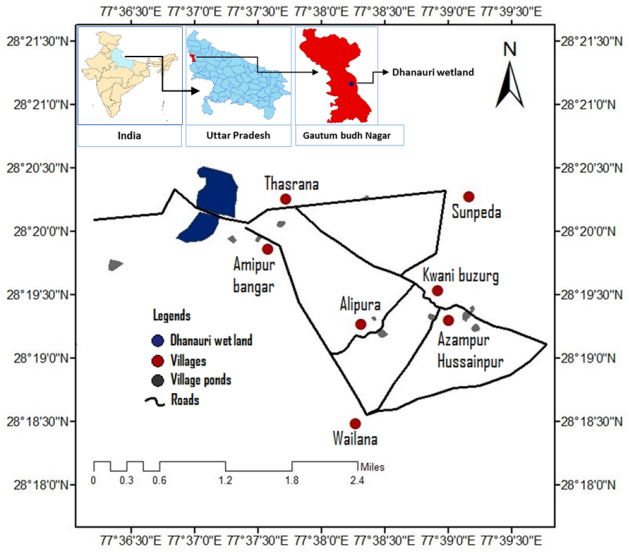

Figure 2. Study area in Gautum Budh Nagar district, Noida, Uttar Pradesh showing roads (black lines) to monitor Sarus Crane nests and their breeding success during the study period, location of villages in red circles with names, wetlands > 40 ha (blue polygon) and village ponds > 8 ha (dark gray polygon). In the top left, the insets show the location of Uttar Pradesh in India (with state boundaries) and the blue spot in Uttar Pradesh blue spot shows Gautum Budh Nagar District.

Nest characteristics and nesting habitat

Out of total 14 nests, the maximum number of nests (n=7) were found in the perennial wetland area. In village ponds there were only 3 nests in 2 different villages namely, Kwani Buzurg (n=1) and Azampur Husainpur (n=2) were observed. The remaining 4 nests were present in the agricultural marshland. Nest height and length were significantly different across the three distinct habitats in the study area ($p<0.05$). At nest locations, the mean water depth in the wetland was significantly greater than in the agricultural land and village pond ($p<0.05$). A greater number of nests within the wetland (n=4) were far from nearby road or buildings, whereas nest recorded in a pond and agricultural land were close to the road and buildings (far ≥ 150m and close ≤ 150m) (Table 1).

Correlation between mean water depth and nest height

The value of $R^2=0.81$ showed that there was a strong positive correlation between the given variable (Figure 6). Therefore, nest height was the function of the depth of water around the nest. Moreover, it was found that in the wetland area, the depth of water was higher as compared to the agricultural marshland and village pond. However, the height of the nest was greater with the lowest water depth in the agricultural marshland.

Breeding success in different habitats

Eggs laid in nests in perennial wetland were exposed to predation when the parents took recesses for foraging and collecting nest material. Consequently, the egg loss was higher in the perennial wetland (69.2%). However, egg loss in the village pond was low (33.3%) in comparison to the perennial wetland and agricultural marshland (62.5%). In the agricultural marshland, 2 nests with eggs were found shifted from their initial position to another location with no known reason, and these nests were deserted.

Figure 3. Nest of Sarus Crane in perennial wetland.

Figure 4. Female individual maintaining nest.

Figure 5. Female individual engaging in rotating eggs.

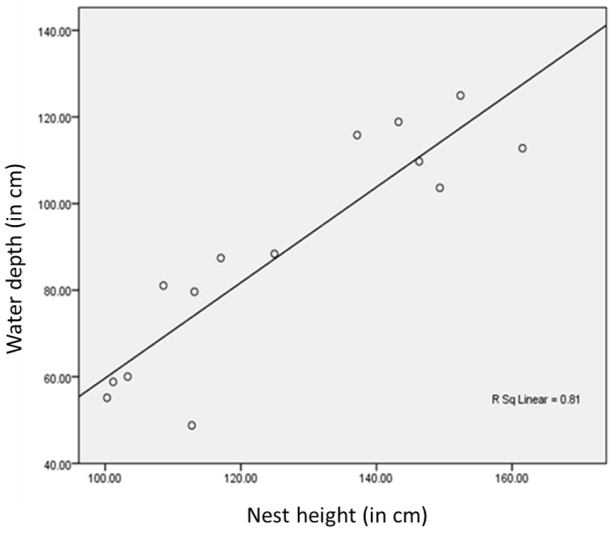

Figure 6. Correlation between mean water depth and nest height.

A total of 13 eggs were laid in perennial wetland, whereas in agricultural marshland and village ponds, the total number of eggs laid was 8 and 6, respectively (Table 2). Hatching success in village ponds (66.6%) was highest, followed by agricultural marshland (37.5%) and perennial wetland (30.7%). Consequently, the overall breeding success was higher in the village pond (50.0%) as compared to the agricultural marshland (25.0%) and perennial wetland (15.3%). However, in perennial wetland, two chicks were found dead, but the cause of their death was unknown. The maximal egg mortality in the wetland area may be due to the flooding, especially in those where water depth was initially greater. Thus, these findings indicated that greater water depth near the nests and distance from the nearest road was not only a key factor to protect the nest as the destruction of eggs due to predation in wetland habitat was minimum (33.33%).

Discussion

A total of 14 nests of Sarus Crane were studied; seven in perennial wetland, four in agricultural land, and three in the village pond. The height and length of the nests were found to be greater in wetland habitat among the three different habitats, suggesting that nest size was a function of habitat utilization for building nest by the Sarus Crane (Kumar & Kanaujia, 2017).

However, in our study, Sarus Cranes built most of their nests in the perennial wetland as the wetland habitat had less probability of incursions from land predators due to greater water depth and distance of the nest from the nearest road. The water depth around the nest protect them from ground predators. Moreover, our finding showed a positive correlation between water depth and nest height, which indicated that nest height, was a function of water depth around the nest. Similarly, a positive correlation was found between water depth around the nest and corresponding nest height from the ground in Whooping Crane (Kuyte, 1995). Therefore, we hypothesize that other than the nesting parameters, several limiting factors like water depth and habitat availability are also responsible for the Sarus Crane nesting in an area.

Among the different species of Cranes, Sarus Crane is unique in building their nest even in small water bodies like village pond present very close to the roads and human habitation (Sundar, 2009). However, nests with greater water depth and less distance from the road in village ponds showed a higher rate of breeding success. In contrast, according to Kumar & Kanaujia (2017), nests with a shorter distance to any road and building, and low water depth around the nest had a lower success rate due to a high level of disturbance. Further, we noticed that flooding of nests in the wetland was the major factor responsible for egg mortality, especially in those nests where water depth was initially greater. However, to save their nests, breeding pairs of Sarus Crane maintained the nest height by continuously adding fresh nesting material from surroundings (Borad *et al*., 2002). Eggs laid in nests in perennial wetland were also exposed to predation when

Table 1. Nesting parameters (Mean ± S.E.) among different habitat in Dhanauri wetland, Uttar Pradesh

Nest variables	Perennial Wetland (N=7)	Agricultural marshland (N=4)	Village pond (N=3)
Nest Length (cm)	*248.63*±3.57 [A]	233.93±3.37 [B]	215.38±4.16 [C]
Nest Height (cm)	144.99±4.40 [A]	104.38±2.86 [C]	112.93±2.44 [B]
Water Depth (cm)	110.59±4.49 [A]	55.69±2.53 [C]	82.71±2.39 [B]
Distance from nearest road (m)	30.77%[E], 69.23%[D]	100.00%[E]	100.00% [E]
Nest Survival	*15.38%*	25.00%	50.00%

Notes: All values are presented in mean ± standard error by one-way ANOVA.
Different capital letters in superscript indicate a significant difference between groups ($p<0.05$).
[D] Distance from nest to the nearest road longer than 150m
[E] Distance from nest to nearest road shorter than 150m

Table 2. Nest survival of Sarus Crane in Dhanauri wetland, Uttar Pradesh

	Perennial wetland	Agricultural marshland	Village pond	Overall success
A. Nest				
Total nests	7	4	3	14
Nest with destroyed clutch	5	3	1	09
Nest with at least one chick	2	1	2	05
B. Egg				
Total laid eggs	13	8	6	27
Destructed eggs	9	5	2	16
By farmers	-	-	-	-
Flooding	6	-	2	8
Predation	2	1	-	6
unknown reason	1	4	-	2
C. Chick				
successful hatched	4	3	4	11
chick mortality	2	-	-	2
predation	2	-	-	2
unknown	-	-	-	-
no information	-	1	1	2
fledged	2	2	3	7
D. Overall breeding Success	15.38%	25.00%	50.00%	25.92%

the parents took recesses for foraging and collecting nest material. In Crane species, both males and females took recesses normally near noon (Zhang *et al*., 2017).

During the present investigation, two nests were found to be shifted from their initial positions on agricultural land. However, the exact reason behind this is still unknown. One possibility is that due to lack of awareness, it is generally believed by the local populations that nesting and foraging activities by Sarus Crane can cause damage to their crops; so, to prevent this damage, they could shift the eggs to another location. In Uttar Pradesh, some proportion of nests in agricultural land, especially in paddy fields, was found to be adversely affected after their removal by farmers to minimize their crop destruction (Sunder, 2009). We also heard jackals call at night in near agricultural land. Dogs, jackals (Walkinshaw, 1973; Clements *et al*., 2007) and crows (Mukherjee *et al*., 2000) are believed to be the known predators of the Sarus Crane eggs. However, we could not determine the cause of the egg mortality in the village pond.

It has been observed that Sarus Crane pair and their chicks remain around their nest until they become free to fly after the completion of the breeding season (Parasharya *et al*., 1989; Ramachandran & Vijayan, 1994). In the case of agricultural land and village pond, the reason behind the mortality of chicks was also not identified. Consequently, the Sarus Crane is a vulnerable species that require conservation efforts. This study on nest characteristics will provide a scientific baseline for future research to better understand the breeding ecology of Sarus Cranes and will be helpful in their conservation.

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